KDP crystals of optical quality were grown under different conditions. For the growth of these crystals, number of parameters have been optimized systematically. High precision temperature control to an accuracy of ±0.01 °C has been achieved by the fabricated optically heated constant temperature bath. Highly transparent KDP crystals of size 50x50x200 mm³ have been grown; the growth rate of this crystal was 4mm/day. The hydrogen and hydroxyl ion concentration in the solution influences the growth; it also modifies the solubility. KDP crystals have been grown at different pH of the solutions and at different starting temperatures. Good quality crystals could be grown at the pH of 5 in the temperature range 50 - 35°C. The habit change has been identified with the variation of pH of the solution.

Metallic dopants blocked the growth along ‘a’ and ‘b’ axes; particularly Fe and Cr additives tapered the crystal; these metal ions as well as Mn ion are preferentially adsorbed on prismatic faces; it has been identified experimentally. The growing technology requires large dimensional crystals which compel the need to increase the growth rate. To grow the crystals with faster rate along ‘a’ and ‘b’ axes, one or more of the following three factors have to be considered. (i) To increase pH of the solution (ii) To avoid the blocking impurities (iii) To increase the supersaturation of the solution. While there is an upper limit for the pH to have equal growth rates on the three directions of KDP, the other two factors are expected to give a leverage but, are assessed to be more critical. They are also believed to be interrelated; the presence of metal impurities demands a higher supersaturation level to enable growth along <100>. The stability of the solution fixes an upper limit for the degree of supersaturation. In this context, the stability of the solution was
measured by means of determining the metastable zone width and it was found to be only 1.5 - 2.0°C for the salt purchased from local vendors. The salt synthesised in the laboratory exhibited a higher metastable zone width of 5-6°C which indicated that the synthesised KDP salt contained less impurities. X-ray studies confirmed the synthesised salt. A few crystals have been grown with faster cooling rates and the range of supersaturations for fast growth has been found to be extended. However, more efforts are needed to achieve the growth rates achieved by Russian Scientists (Chernov et al 1990; Zaitseva et al 1991).

The presence of deuterium in the place of hydrogen enhanced the electro-optic property of KDP crystals. Hence, deuterated KDP crystals of size 3 x 3 x 5 cm³ have been grown. DKDP crystals have been grown with transparent capping without any inclusion at a pH of 2.3 on KDP seed. Because of the mismatch of lattice at the boundary of KDP seed, parallel cracks along the 'c' plane have been observed. At higher isotopic concentration and at higher growth temperature, the coexistence of monoclinic and tetragonal crystals was observed. After taking out the monoclinic crystals to atmosphere, they transformed into tetragonal structure and lost their transparency. Some interesting features have been observed on the transforming monoclinic DKDP crystals when studied under the microscope. The hexagonal pattern observed on monoclinic crystal disappeared after 48 hours.

X-ray powder patterns have been taken for all the crystals and the different diffracting planes have been indexed. The lattice parameters have been calculated from these measurements. Etching is one of the important tools to find out the defects in the crystal. For KDP, boat shaped pits were observed using water as an etchant and square shaped pits resulted on monoclinic DKDP crystals.
Transmission spectra were taken for pure KDP, metal doped KDP and the deuterated KDP crystals. The dopants did not show any variation in the range of transmission; the percentage of transmission was found to be less in Mn doped KDP crystals. Laboratory synthesised crystal showed higher percentage of transmission (90-95%) compared to the crystals grown from locally available salt. DKDP crystals showed that the range of transmission was extended in both UV and near IR region (200-2000nm). This is due to the weak bonding between deuterium and oxygen than the hydrogen-oxygen bonding.

Electro-optic modulator (Pockel's cell) has been fabricated using optically polished c-cut plates of KDP crystal. The half wave voltage $V_{1/2}$ and the electro-optic coefficient have been determined with He-Ne laser (6328Å) and they were found to be 10.0kV and $9.0 \times 10^{-12}$ m/V respectively which are comparable with the literature values.

The semi-organic laser material, L-arginine phosphate, has been grown. The formation of microbes in LAP solution is a severe problem and has been partly eliminated by different additives in LAP solution. Transparent crystals of sulphate mixed LAP (LAPS) have been grown and their characteristics have been studied. The morphology of LAPS crystals was different from that of the pure one. On adding sulphuric acid, the growth rate of the crystal was found to be enhanced by 25% along the 'c' axis, while the growth rate along the other two axes showed a marginal increase compared to that of pure crystal. Single crystal X-ray analyses have been carried out and the lattice constant 'a' is found to be increased in the case of sulphate mixed crystal. The planes were indexed by powder X-ray studies. The presence of sulphate was identified from IR studies. Microhardness of LAP was found to be more than that of LAPS crystal. This is due to the loosely packed lattice as revealed from the X-ray analysis. Dielectric permittivity of these crystals was about 4-8 and was constant over the temperature range 30-140°C indicating that there is no physical or chemical transformation in these crystals. Rectangular etch pits
were observed on (100) plane when etched with water and these pits have been bound by (101) and (110) planes; dissolution rates in the corresponding directions being higher, these pits are formed on the (100) surface. This is related to the growth kinetics of the crystal. These crystals have a comfortable working transmission range (230nm - 1900 nm) which is determined from transmission spectrum analysis.

The most widely used pyroelectric materials of Triglycine sulphate family crystals have been grown. The phosphate addition in TGS was found to extend the shelf life of the mother solution. In addition to that, the polar planes were well developed which could be used in thermal detection and imaging. To estimate the quantity of sulphur and phosphorus, ICP studies have been carried out; only small quantity of phosphorus has been found to have entered into the TGS lattice. Metal doped TGSP crystals were also grown and these dopants did not affect the morphology of the crystals. The amount of metal ions was estimated by chemical analysis. Identical structured amino molecules have been introduced in TGS crystal to evaluate the performance of these crystals in pyroelectric detection. Some of them changed the crystal morphology; especially the alanine mixed crystal had different growth rates in positive and negative b-axes.

Structural, electrical, mechanical and defects characteristics for the TGS family crystals have been carried out. Lattice parameters have been calculated from single crystal X-ray and powder diffraction studies. Domain pattern on TGS crystals was obtained by etching the surface with KOH solution in methanol. Dielectric permittivity of all the mixed and doped crystals was found to be reduced. Phosphate substituted TGS showed higher pyroelectric coefficient. Most of the amino acid mixed crystals enhanced the pyroelectric coefficient- especially the valine mixed TGS crystal. In the case of histidine mixed crystal, pyroelectric coefficient was found to be reduced. From the hysteresis measurements, saturation polarization and coercive field for all these crystals have been determined. The metal dopants are believed to rigidify the TGSP lattice as revealed from piezoelectric studies.
7.2 SUGGESTIONS FOR FUTURE WORK

KDP crystals have been grown successfully to dimensions of 50 x 50 x 200 mm$^3$ and 30 x 30 x 80 mm$^3$ by conventional and fast growth processes respectively. The laser fusion experiments need KDP crystals of larger area of cross-section 200 x 200 x 400 mm$^3$. Hence, it is necessary to establish the process for the growth technology for large size crystals from aqueous solution. Further purification of the raw material is quite essential for the success of growing larger size crystals by fast growth process. Deuterated KDP crystals have been grown with the deuterium concentration of 85%. In this regard, investigations should be made to grow DKDP crystals with higher deuterium concentration. Attempts should be made to fabricate electro-optic modulators and second harmonic generators from the grown crystals.

Another interesting avenue is that the L-arginine phosphate has optical absorption at infrared wavelengths (1.06 µm) of interest in many applications of high power solid state lasers - ICF (Inertial Confinement Fusion) experiments, in particular. As deuteration can reduce this absorption, highly deuterated LAP (d-LAP) is the material preferred for such applications.

Growth of LAP crystal is optimized. However if the growth span is longer, the formation of microbes is unavoidable. The author feels that deeper investigation is required on the suppression of microbes in the solution. An attempt can be made to grow the crystals of other semi-organic crystals like L-asparagine phosphate, L-valine phosphate etc. and they may be tested for their electro-optic and non-linear properties.

Many pure and mixed crystals of TGS family have been grown. A few mixed crystals of this family showed good device quality characteristics for IR detectors. The deuterated analog of TGS family crystals can be grown. Attempts should be made to fabricate IR detectors from these crystals.